When dried at 105° C., the substance loses only two molecules of water of crystallisation :—

0·6120 gramme air-dried substance lost at 105° C. 0·0640 gramme H_2O = 10·46 per cent.

Calculated for $C_4H_4O_7NaSb.2H_2O$. H_2O = 10·49 per cent.

The remaining half molecule is subsequently lost *in vacuo* over sulphuric acid.

0·6120 gramme substance dried at 105° C. then lost *in vacuo* over sulphuric acid 0·0110 gramme H_2O. Total loss = 12·25 per cent.

On exposure to air, the two and a half molecules of water of crystallisation are again taken up, but the salt does not deliquesce.

0·5370 gramme substance dried *in vacuo* over sulphuric acid, on exposure to air ncreased in weight to 0·6066 gramme.

The Influence of Increased Barometric Pressure on Man. No. 4.—The Relation of Age and Body Weight to Decompression Effects.

By Leonard Hill, F.R.S., and M. Greenwood, Jun., M.R.C.S.

(Received October 1,—Read December 5, 1907.)

Statistics of caissons and diving works tend to suggest that the percentage number of men affected injuriously by exposure to compressed air increases with age.

Pol and Watelle (1) record that men between 18 and 26 stood the work best, and that of the 25 men dismissed for illness from the works under their inspection, 19 were over 40 years old, 5 over 30, and 1 over 28 years.

Catsaras (2) investigated 62 instances of paralysis among sponge divers, and we find that, of these, 33 were over 30 years old, 17 over 25, 11 over 20, and 1 over 19. These men dived about 140 feet, spent about 10 minutes below, and were decompressed in about one minute.

Evidently this variation might depend on—(i) the actual age difference; (ii) on an increase in mean body weight with age; (iii) on a combination of (i) and (ii); (iv) it might be purely random. We cannot absolutely exclude (iv) in the instance of caisson works unless we know the total number of men at each age employed, figures which do not seem to be available.

Snell (3) gives the following table (Table I) of his observations, made at the Blackwall Tunnel works.

Unfortunately, column 2 gives not the total number employed, but only those who submitted themselves to medical inspection, which was not, at first, compulsory.

Table I.

Ages.	Number of men examined and passed.	Number of men taken ill whose ages are recorded.	Proportion of illnesses to every 100 men passed.
15—20	55	0	0
20—25	145	15	10·3
25—30	152	37	24·3
30—35	91	19	20·9
35—40	61	14	22·9
40—45	38	10	26·3
45—50	3	5	166·0
Totals...	545	100	

Supposing, however, that the men examined by Snell were a fair sample of the workers, they can be used as a measure of the age distribution in the whole class of employés. If there be no special liability to illness at any particular age, the number of men of a given age who suffer should be simply $n'/N \times$ total number of cases, where $N = 545$, n' the number of men within the specified age limits as recorded above. In this way we obtain the subjoined table :—

Table II.

Ages.	Actual number affected.	Theoretical number.
15—20	0	10·09
20—25	15	26·61
25—30	37	27·89
30—35	19	16·70
35—40	14	11·19
40—45	10	6·97
45—50	5	0·55

Applying the usual test for goodness of fit (4) to this distribution, χ^2 is found to be 56·44, so that the odds are more than a million to one against a worse agreement between theory and observation if the deviations are merely a result of random sampling.

In the same way, if we group the 143 cases with recorded ages given by v. Schrötter (2), from the Nüssdorf Works, and assume Snell's age distribution to hold for these works (a not very improbable assumption, since we know that many caissoniers travel from place to place through England and Europe), we have :—

Table III.

Ages.	Actual number affected.	Theoretical number.
15—20	1	14·43
20—25	35	38·04
25—30	43	39·88
30—35	32	23·87
35—40	19	16
40—45	8	9·97
45—50	5	0·79

and χ^2 is 39·13, or the odds are about three in a million. It will be seen, therefore, that there is some evidence in favour of an age bias, but the statistics are not sufficiently detailed to give much information.

Returning to (i), (ii), and (iii), it is clear that we must have considerable difficulty in isolating (i) and (ii) under experimental conditions. Thus, in dealing with such animals as rats, it is not easy to obtain a large number of the same age but markedly different body weights. If we attempt to overcome the difficulty by comparing animals of different species, a new factor is involved, the importance of which cannot at present be estimated.

It must, therefore, be admitted that in the results about to be detailed the observed differences cannot be ascribed wholly to body mass; other changes associated with growth and decay may be influential, and we must certainly not compare directly animals of different species. With these reservations, regarding which more will be said later, we shall demonstrate an appreciable difference in liability to caisson disease when animals of different weights are employed.

It is known that the velocity of the circulation and rate of respiratory exchange in small mammalia is greater than in large animals, the relatively larger surface exposure in the former necessitating a higher rate of metabolism. Since the saturation of the tissues with gas, together with its removal from them, are functions of the blood, it follows that the processes should require less time in small than large animals. If, then, we expose large and small animals to the influence of compressed air for so long a time that both will contain large quantities of dissolved gas, a decompression rate dangerous for the former should be safe for the latter.

Our experiments have been carried out on rats, mice, cats, rabbits, and guinea-pigs.

(a) *Rats.*

In all experiments the animals were exposed to a pressure of +105 lbs. for periods varying from a-half to two hours; in most cases the exposure was

for one hour. Decompression was effected in four and a-half to seven seconds. In all, 85 rats have been used—54 small, 31 large; of the small rats, 14, or 25·9 per cent., died; of the large animals, 24, 77·4 per cent., died. Unfortunately, all the rats were not weighed, but we have records of the weight in 65 cases, and although this is not a great many from the statistician's point of view, it is sufficient to make an analysis interesting. The following attempt has been made to measure the relationship between decompression effects and body weight.

As we have no quantitative scale of decompression effects, the most satisfactory method to employ would seem to be that of fourfold division, obtaining the coefficient of correlation in the ordinary way (5). We accordingly made the following table :—

Table IV.

Weight in grammes.	Recoveries.	Deaths.	Totals.
Below 124	28	13	41
Above 124	6	18	24
Totals	34	31	65

From this r was calculated to be $0·625 \pm 0·095$.

At first sight this would suggest a very close relationship between low weight and immunity from illness, but it is more than doubtful whether the fourfold method is applicable.

For this process to be valid it is necessary that the distribution should be normal; thus, the modal severity of caisson illness should be neither among the very slight nor the very severe cases. As a matter of fact, human statistics show that "bends," slight decompression effects, are vastly more frequent than severe or moderately severe paralysis, so that the severity distribution is, perhaps, skew, and r, as found above, ceases to be a satisfactory measure of association. We have, however, two more tests of statistical relationship, the correlation ratio (6)

$$\left(\eta = \frac{\text{Standard Deviation of Means of Arrays}}{\text{Standard Deviation of the Character}}\right)$$

and the coefficient of mean square contingency (C_1) (7). We can calculate η readily; the mean weight of all the rats was 122·87 grammes, the standard deviation 67·08; the mean of survivors was 91·62 grammes, of victims 157·15, and $\eta = 0·489$.

As a matter of fact this value differs from r by less than three times

the latter's probable error, but this does not prove linearity of regression,* nor can we apply Blakeman's test for linearity (8), since the scale of caisson illness is not quantitative.

Finally, the mean square contingency was determined by means of the grouping shown in Table V, and proved to be $0·544 \pm 0·078$.†

While, therefore, the exact value of the relationship between body weight and decompression effects is hardly expressible in terms of normal correlation, it can scarcely be less close than that implied by a contingency coefficient of at least 0·3; in other words, the two variables are quite definitely correlated. We have at present no means of extending this analysis to any other group of animals.

Table V.

Weight in grammes.	Survived.	Died.	Totals.
40— 60	5·5	0·0	5·5
60— 80	12·0	4·0	16·0
80—100	8·5	2·0	10·5
100—120	2·0	6·5	8·5
120—140	1·0	1·0	2·0
140—160	2·0	4·5	6·5
160—180	1·0	6·0	7·0
180—200	1·0	1·0	2·0
200—220	1·0	0·0	1·0
220—240	0·0	3·0	3·0
300—320	0·0	1·0	1·0
340—360	0·0	2·0	2·0
Totals	34·0	31·0	65·0

Observations falling at a class limit (*e.g.*, 60) were reckoned as 0·5 in each class.

(b) *Rabbits.*

Our experiments have not been numerous, but the following are suggestive :—

Exp. 5.11.06.—Three rabbits, one full grown, another of medium size, a

* In any case, but little weight can be attached to the value obtained for η, since there are only two arrays available. It seemed best, however, to record the value for comparison.

† Deduced by multiplying the probable error obtained from the ordinary formula by 4/3. The complete formula of Blakeman and Pearson (9) gave a lower value, perhaps owing to an undetected slip in the rather involved arithmetical computation. The exact significance of the coefficient may be realised by comparing its value with those obtained by Pearson (7) for the contingency between undoubtedly related variables :—

Stature in father and son ... ... $C_1 = 0·513$
Hair colour in brothers ... ... $C_1 = 0·614$
Occupation in fathers and sons ... ... $C_1 = 0·6275$

See pp. 21, 22 (7).

third smaller one, were exposed to a pressure of 105 to 110 lbs. for 51 minutes, and decompressed in four and a-half seconds.

The biggest rabbit went into convulsions in three and a-half minutes, and the medium-sized one was affected shortly after. On unscrewing the chamber both were found dead, exhibiting the usual *post-mortem* appearances. The smallest rabbit seemed normal.*

(c) *Cats.*

Exp. 27.7.06.—A pregnant cat and half-grown kitten were exposed to + 100 lbs. for 30 minutes, and decompressed in six seconds. The cat died in 20 minutes.

Autopsy.—Veins and arteries full of bubbles and froth. Lungs emphysematous and congested in patches, owing to air embolism.

Fœtuses.—Air bubbles in amniotic fluid, which frothed on pouring into a beaker; air in fœtal lungs and liquid contents of stomachs, none visible in the blood. The kitten, which appeared normal, was killed for examination within a minute of opening the chamber. No bubbles were seen. The bladder was full of urine, which frothed like champagne when poured into a beaker.

25.1.07.—An old cat and a half-grown cat were exposed to + 110 lbs. for 85 minutes, and decompressed in seven seconds. The old cat was found to be dead on opening the chamber, the young cat survived 20 minutes.

26.7.07.—An old cat and two kittens (half grown) exposed to + 100 lbs. for 30 minutes and decompressed in 10 seconds. The cat was found dead on opening the chamber, the two kittens survived.

Collecting our results on rabbits and cats, we have :—

Table VI.

Animals.	Died.	Survived.	Percentage mortality, with probable errors.
Young rabbits	5	9	35·7 ± 8·64
Old rabbits	2	1	66·67 ± 18·36
Young cats	6	6	50·0 ± 9·735
Old cats	6	0	100·0 ± 8·0 (?)

The difference in the first group is hardly sensible (30·97 ± 20·3), in the second, perhaps, significant (50 ± 12·6).

* Although this animal had no decompression symptoms, it died four days later from pneumonia, produced probably by the rupture of the lung tissue, which occurs in many cases on sudden decompression, followed by infection.

If young animals have an advantage here also, it is, to say the least, not very marked, and we may reasonably conclude that we have to deal with a group in which the absolute body mass of all members is so great that the decompression period (four to seven seconds) is too short even for the least bulky subjects.

In addition to this question of absolute body mass, there appear to be quite marked variations in different species. Thus, it by no means follows that animals of species A will stand decompression better than much heavier animals of species B. So far as our observations go, the guinea-pig is a peculiarly unfavourable subject, even when young and light animals are used; in 10 experiments we have had eight fatalities.

12.7.07.—Nine guinea-pigs were exposed to + 105 lbs. for one hour, and decompressed in four seconds. Eight (weights, 144, 72, 77, 164·5, 75, 114·5, 108·5, 81 grammes) were dead, and the ninth (108 grammes) paralysed, but recovered completely in a few days.

We shall next give details of comparative experiments, which suggest the same conclusion.

Rabbits and Cats or Kittens.

26.7.06.—Four rabbits (about one month old), three kittens (about three weeks old) were exposed to + 100 lbs. for 30 minutes, and decompressed in seven seconds. Two rabbits died and one kitten.

21.11.06.—Half-grown cat (3 lbs. 2 ozs.) and large rabbit (3 lbs. 8 ozs.) were exposed to + 105 lbs. for 35 minutes. Decompression time, four seconds. The cat was dead on removal, the rabbit unaffected.

Rabbits and Guinea-pig.

10.5.07.—Two young rabbits (3 lbs. 6 ozs.; 3 lbs. 2 ozs.), one guinea-pig (1 lb. 8 ozs.) exposed to + 100 lbs. for 30 minutes, and decompressed in seven seconds.

The rabbits died within 15 minutes, and the guinea-pig died in the night, showing signs of pulmonary hæmorrhage.

Rats and Rabbits.

10.7.07.—Two rats (435 grammes, 87 grammes), one rabbit (1304 grammes) exposed to + 105 lbs. for $1\frac{1}{2}$ hours, and decompressed in four seconds.

All were dead on removal.

Evidently these results are indecisive.

Rats and Mice.

7.12.06.—Six rats and six mice were exposed to + 115 lbs. for 25 minutes, and decompressed in four seconds. Four rats died (162, 104, 120, 152

grammes), two (107, 87 grammes) survived. All the mice survived (18, 18, 12, 10, 11, 10 grammes).

24.1.07.—Fifteen mice and five half-grown rats were exposed to + 115 lbs. for two hours, and decompressed in five seconds. Three rats and 15 mice were unaffected. One rat was dead (froth in heart and veins), one paraplegic.

In all our experiments on rats and mice, we find:—

	Died.	Survived.	Percentage mortality.
Rats	6	10	37·5±8·16
Mice	3	27	10 ±3·69
Difference	—	—	27·5±8·96

The evidence in favour of the view that mice can stand rapid decompression better than rats is reasonably strong. Here body weight is apparently more important than age, full-grown mice being better subjects than young rats.

Rats and Kittens.

22.5.07.—Two full-grown rats (11 and 12½ ozs.), and three young kittens (11, 11, 10 ozs.) were exposed to + 120 lbs. for 55 minutes. Decompression time, 5½ seconds. One rat was dead on removal; two kittens and the other rat died in a few minutes; one kitten survived. P.M.: The air emboli usually observed were present in all three animals.

This experiment shows little advantage on the side of the young animals.

The results we have described may be compared with the observations of earlier workers which we have collected and tabulated. These seem to show a relative immunity of the smaller animals to rapid decompression, and a death rate of almost 100 per cent. in the case of cats and dogs at pressures above six to seven atmospheres.

Table VII.

Pressure in atmospheres.	Period of decompression.	Result.
Sparrows (Bert) (10).		
7	A few seconds	Death.
8 (for 5 mins.)	"	Nil.
8 (for 2 mins.)	"	Nil.
8 (for 2 hrs.)	"	Death.
$9\frac{1}{2}$ (1 hr. 35 mins.)	"	Nil.
10 (some minutes)	"	Nil.
12 "	"	Death.
14 "	"	No immediate result; died next day.
14 "	"	Death.
15 "	"	Death.
Mice (Phillipon) (11).		
5 (20 mins.)	1 min.	Nil.
12 (1 hr.)	1—2 secs.	Nil.
5 (1 hr.)	Momentary	Death.
Rats (Bert) (10).		
$5\frac{1}{2}$ (1 hr. 15 mins.)	A few seconds	Nil.
$6\frac{1}{2}$ (1 hr. 45 mins.)	"	Nil.
$6\frac{1}{2}$ ($\frac{3}{4}$ hr.)	"	Nil.
$8\frac{1}{2}$	2 mins.	Death (2 animals).

Table VIII.

Pressure in atmospheres.	Period of decompression.	Result.
Rabbits (Bert) (10).		
$6\frac{1}{2}$ (1 hr. 45 mins.)	$4\frac{1}{2}$ mins.	Nil.
7 (a few minutes)	2—3 "	Nil (2 animals).
8 (5 mins.)	2—3 "	Nil.
$8\frac{1}{2}$	2—3 "	Nil (2 animals).
Rabbits (Phillipon) (11).		
4 (1 hr.)	Momentary	Death.
$5\frac{1}{2}$ "	"	Death.
5·6 "	"	Death.
7 (5 mins.)	"	Nil.
7 (1 hr.)	15 mins.	Slight symptoms; recovered.
Cats (Bert) (10).		
8 (5 mins.)	2—3 mins.	Paralysis and death.
10 (9 mins.)	2—3 "	Death.
10	2—3 "	Paralysis.

Table VIII—*continued.*

Pressure in atmospheres.	Period of decompression.	Result.
	Dogs (Bert) (10).	
3½	1—2 mins.	Nil.
4 (15 mins.)	2—3 ,,	Nil.
4½	2—3 ,,	Nil.
5 (30 mins.)	2—3 ,,	Nil.
5½ (4 hrs.)	20 secs.	Nil.
6 (30 mins.)	20 ,,	Nil.
6 (2 hrs.)	20 ,,	Nil.
6 (a few minutes)	20 ,,	Slight paralysis.
6 (3½ hrs.)	20 ,,	Death.
6½ (a few minutes)	4½ mins.	Nil.
7 ,,	2 ,,	Paraplegia and death.
7 (7 mins.)	2 ,,	Paraplegia and death.
7 (10 mins.)	2½ ,,	Paralysis and death.
7½ (15 mins.)	2 ,,	Paralysis and death.
7 (a few minutes)	2¼ ,,	Paralysis and death.
7¼ ,,	1¼ ,,	Paralysis and death.
7¼ ,,	1¼ ,,	Paralysis and death.
7¼ ,,	2 ,,	Paralysis and death.
7½ ,,	2 ,,	Slight paralysis.
7½ ,,	2 ,,	Paralysis and death.
7½ ,,	2 ,,	Nil.
7¾ ,,	3 ,,	Paralysis.
8 ,,	3—4 ,,	Paralysis and death.
8¼ ,,	3 ,,	Paralysis and death.
8¼ ,,	3 ,,	Paralysis and death.
8½ ,,	2½ ,,	Paralysis and death.

Table IX.—Catsaras' Observations on Dogs (12).

Water depth.	Atmospheres (approximate).	Exposure.	Decompression time.	Result.
metres.			secs.	
34·0	4½	16 mins.	40	Nil.
34·0	4½	10 ,,	50	Nil.
38·0	4¾	21 ,,	60	Nil.
40·0	5	6 ,,	60	Nil.
43·0	5⅓	4 ,,	60	Nil.
34·0	4½	2½ hrs.	40	Temporary paralysis.
36·0	4½	2 ,,	50	,, ,,
38·0	4⅔	1¾ ,,	60	Death.
40·0	5	1 ,,	60	Paralysis and death.
43·0	5⅓	1 ,,	60	Dyspnœa; recovered.
43·7	5½	2 ,,	60	Nil.
43·7	5½	1½ ,,	60	Paralysis.
47·2	5⅔	1 ,,	50	Temporary paralysis.
53·2	6⅓	½ ,,	40	Paraplegia.
55·4	6½	25 mins.	60	Death.
60·0	7	30 ,,	60	Death.
45·0	5½	30 ,,	30	Paraplegia.

Further, the observations of L. Hill and J. J. R. Macleod led them to conclude that all adult dogs and cats died when decompressed in a few seconds after an hour's exposure (or more) to eight atmospheres.

If the relative immunity of small animals be due to the greater velocity of the circulation in them, it follows that any agent which damages or slows the circulation would deprive them of their safeguard. We have tested this by exposing small animals to air pressure and then pumping chloroform into the chamber, or upsetting a bottle containing the anæsthetic placed inside.

8.5.07.—Guinea-pig (1 lb. 4 ozs.) placed in chamber with $CHCl_3$. At 11.30 A.M., pressure raised to + 100 lbs.; 11.35, beginning to show signs of anæsthesia; 12.12, decompressed from + 75 lbs. in five seconds. Dead on removal. P.M.: Heart auricles contained an enormous quantity of froth. Every vessel examined full of bubbles. Lungs almost bloodless in appearance. Renal vessels frothed on incision. Gall bladder, greatly distended, bile frothed almost like soda water.

Control 10.5.07.—Guinea-pig (1 lb. 8 ozs.) exposed to + 100 lbs. for 30 minutes, and decompressed in seven seconds. The animal seemed normal on decompression, but was found dead next day (Saturday). P.M. (Monday): There were signs of pulmonary hæmorrhage, but the body was decomposing.

15.5.07.—Three young rats (4 ozs., 3 ozs., 2 ozs.) and a kitten were compressed at 12.50 P.M. to + 110 lbs. At 2.8, chloroform was pumped into the chamber, and at 2.11, when they were all lightly anæsthetised, decompression was effected in five and a-half seconds. On opening the chamber the kitten and one rat were found dead. The other two rats died in a few minutes. P.M.: All exhibited an enormous amount of gaseous embolism except the rat which survived longest, and even in this case many emboli were seen, especially in the vena cava inferior.

These experiments, especially the last, are in favour of the view that immunity does depend on a rapid circulation.

In considering the practical bearing of our results, it is to be remembered that the conditions which enable a small animal rapidly to discharge an excess of dissolved gas also lead to its more rapid saturation. Hence, *short* exposures are relatively more dangerous for small than large animals. The advantages of small body mass and youth should accordingly be more apparent among caisson workers than in diving operations; we are not acquainted with any statistics bearing on this point.

It is interesting to note that we have no reason to think that small animals are more susceptible to oxygen poisoning than large ones. The following observations of L. Hill, J. J. R. Macleod, and C. Ham are suggestive of this:—

Table X (13).

Animal.	Atmospheres of air.	Period of exposure.	Result.
Mouse	8	27 hrs.	Pneumonia.
Mouse	11	$1\frac{1}{2}$ „	Death.
Cat and 4 kittens	8—6	24 „	Pneumonia.
Dog	8	24 „	Gasping respirations; recovered.
	Atmospheres of O_2 (about 90 per cent.).		
Mouse	6	$2\frac{1}{2}$ hrs.	Pneumonia.
Rabbit	6	$1\frac{1}{2}$ „	„
Rat	6	$1\frac{1}{2}$ „	„
Cat	6	$5\frac{1}{2}$ „	„
Mouse	5	12 mins.	Convulsions.
Mouse	5—6	32 „	„
Mouse	$6\frac{1}{2}$	5 „	„
Rat	6	32 „	„
Rabbit	6	17 „	„
Cat	6	3 hrs. 30 mins.	„
Cat	4—5	15 mins.	Nil.
	7	$3\frac{1}{2}$ „	Convulsions.
Cat	5	$3\frac{1}{2}$ „	„
Cat	$4\frac{1}{2}$	6 „	„
Cat	$2\frac{2}{3}$	1 hr. 20 mins.	„
Young rabbit Young mouse Small mouse (16 grammes) Large mouse (26 grammes) Small rat (50 grammes)	$2\frac{2}{3}$ $4\frac{1}{3}$	1 hr. 40 mins. 15—20 mins.	Nil. All the animals convulsed.

In the case of the lungs the action of the oxygen is direct, and there is no reason to suppose that the size of the animals should have any influence here. As to the convulsions, Lorrain Smith (14) has shown that these are caused not by the amount of oxygen combined, but by the tension of oxygen dissolved in the blood. Convulsions are as readily produced in an animal whose blood is half saturated with carbon monoxide as in the normal state. The immediate factor in their causation is unknown.

Conclusions.

1. Small mammals are relatively immune from decompression effects.
2. This immunity depends on rapidity of circulation, and may be destroyed by damaging the latter with chloroform.
3. Age is probably important *per se*, but of far less importance than body weight. We have no convincing proof that two animals of the same weight but different ages would exhibit unequal resisting powers.
4. There is no evidence that small animals are more quickly poisoned by high pressures of oxygen than large ones.

The practical outcome of this research is that young men of small body weight and possessing a vigorous circulation should be selected for compressed air works.

REFERENCES.

(1) Quoted by Paul Bert, 'La Pression Barométrique,' Paris, 1878, pp. 379—383.
(2) Quoted by Heller, Mager, and v. Schrötter, 'Luftdruckerkrankungen, etc.,' Wien, 1900, vol. 1, p. 276.
(3) Snell, 'Compressed Air Illness,' London, 1896.
(4) W. P. Elderton, "Tables for Testing the Goodness of Fit of Theory to Observation," 'Biometrika,' vol. 1, p. 155, 1903.
(5) K. Pearson, "On the Correlation of Characters not Quantitatively Measurable," 'Phil. Trans.,' A, 1900, vol. 195, pp. 1—47.
(6) K. Pearson, "On the Theory of Skew Correlation and Non-Linear Regression," 'Drapers' Company Research Memoirs,' Biometric Series, No. 2.
(7) K. Pearson, "On the Theory of Contingency and its Relation to Association and Normal Correlation," 'Drapers' Company Research Memoirs,' Biometric Series, No. 1.
(8) J. Blakeman, "On Tests for Linearity of Regression in Frequency Distributions," 'Biometrika,' 1905, vol. 4, pp. 332—350.
(9) J. Blakeman and R. Pearson, "On the Probable Error of Mean Square Contingency," 'Biometrika,' 1906, vol. 5, pp. 191—197.
(10) P. Bert, 'La Pression Barométrique,' Table 18, p. 954.
(11) Phillipon, 'Comptes Rendus de l'Acad. d. Sciences,' 1892, vol. 115.
(12) Quoted by Heller, Mager, and v. Schrötter, *op. cit.*, p. 760.
(13) Hill and Macleod, 'Journ. of Hygiene,' 1903, vol. 3, p. 401.
(14) J. Lorrain Smith, "Pathological Effects due to Increased Oxygen Tension," 'Journ. of Physiol.,' 1899, vol. 24, p. 19.